THP Snow OSSE Activities

Carrie Vuyovich, Sujay Kumar, Rhae Sung Kim, Paul Houser, Mike Durand, Jessica Lundquist, Lawrence Mudryk, Chris Derksen, Camille Garnaud, Ana Barros, Melissa Wrzesien, Adele Reinking, Jeremy Johnston, Bart Forman, Jeff Deems, Jiyue Zhu, Nicoleta Cristea, Justin Pflug, Yueqian Cao, Ed Kim, Mel Sandells, HP Marshall, DK Kang, Sharun Tan, Glen Liston, Victoria Ily, Leu Tsang

AGU SnowEx TownHall
13 December, 2018

Objective

Overall: How can we use a Snow Observing System Simulation Experiment (OSSE) to support SnowEx?

Phase 1: Snow Ensemble Uncertainty Project (SEUP): Modeling exercise to characterize SWE uncertainty across North America to identify regions and temporal periods of high variability.

Phase 2: Higher resolution Snow OSSE to evaluate impact of assimilated SWE observations to improve snow characterization

Phase 3: Snow OSSE to test forward modeling approach assimilating raw observations

Phase 1: SEUP

Science Questions:

- Where are the areas of high and low uncertainty in SWE at different times of the year, and for different years?
- What factors govern spatial variability in SWE uncertainty? How do those change throughout the season, and for different years? Specifically, what is the role of mountains, forests, albedo, high precipitation / deep snow, etc., along with the associated uncertainty, in determining spatiotemporal SWE uncertainty patterns?

Plan: Use the Land Information System (LIS) framework to run an ensemble of models and forcing datasets and compare results. Assess the results to help select field campaign sites for further investigation.

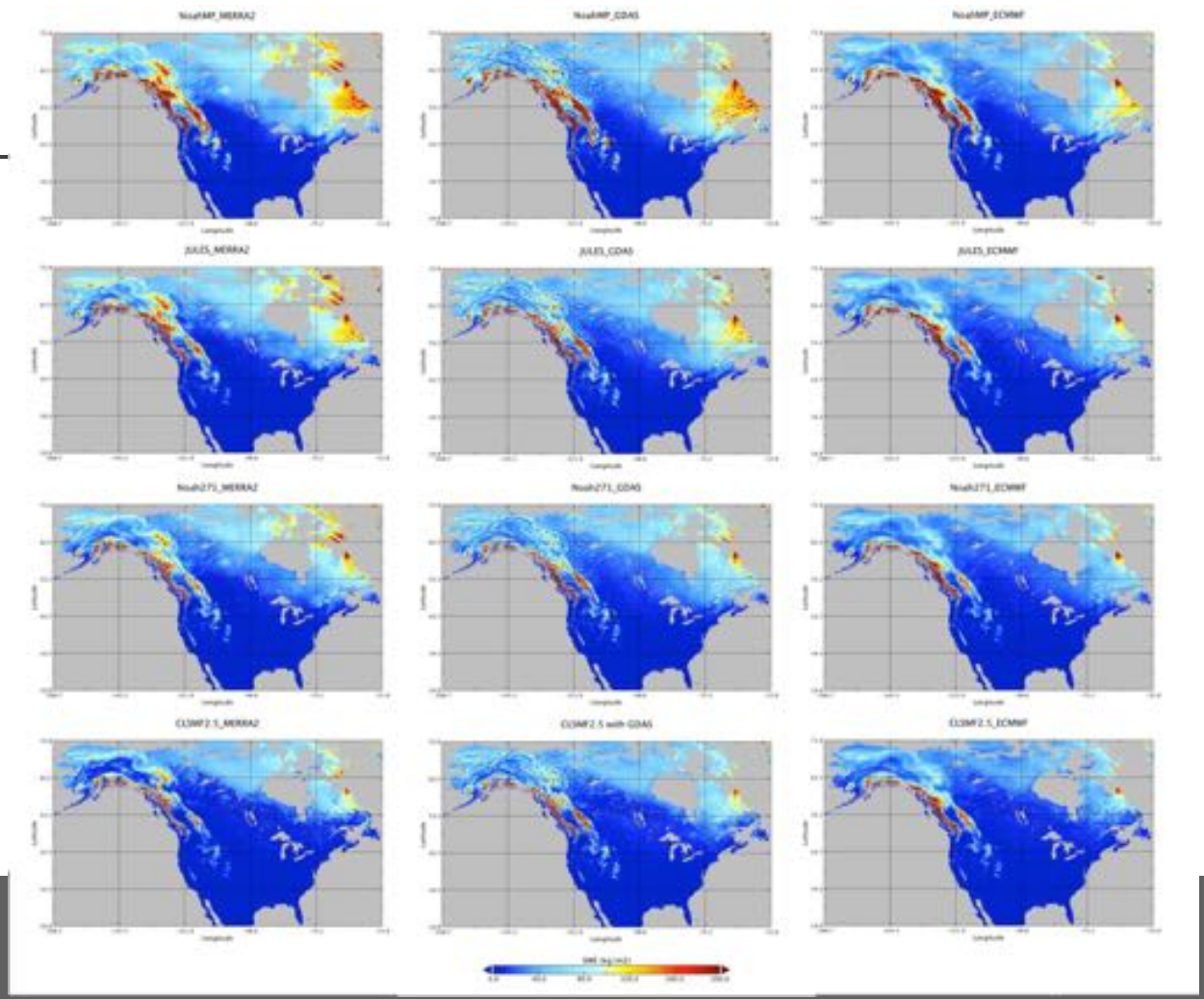
Snow Ensemble Uncertainty Project (SEUP)

- MODELS: LIS models – Noah-MP (3 layer snow), JULES (1-layer snow), Catchment (3-layer snow), Noah (1-layer snow), Liston model: SnowModel (multiple layers, run independently)
- FORCING: Realistic forcing uncertainty – MERRA2-corrected, GDAS, ECMWF
- DURATION: 2000-2017, throw out first 9 years as spinup. Analysis on 2010-2017
- ROUTING: HyMAP
- RESOLUTION: 5km
- TIME STEP: 3 Hours

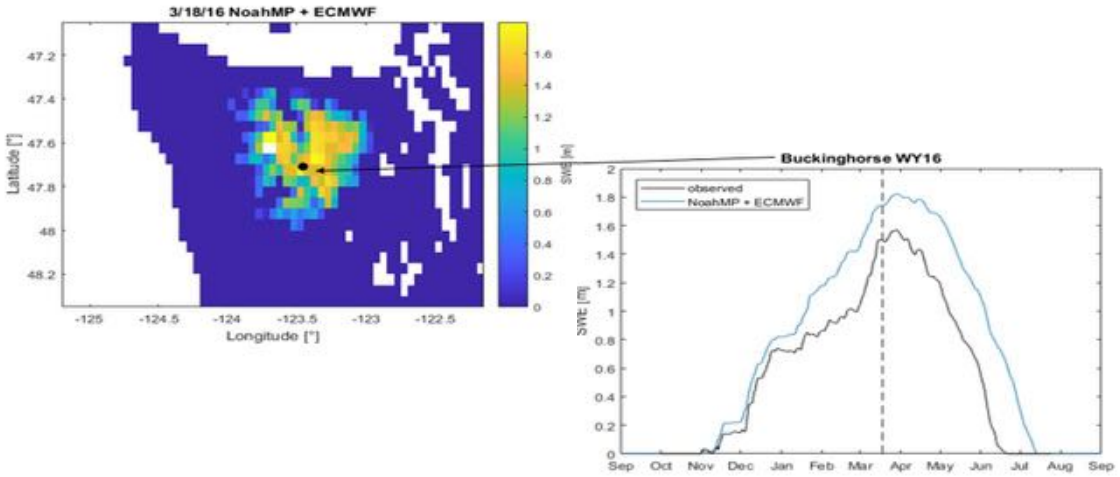
	MERRA2	GDAS	ECMWF
Noah-MP			
JULES			
Catchment			
Noah 2.71			
SnowModel			

Results

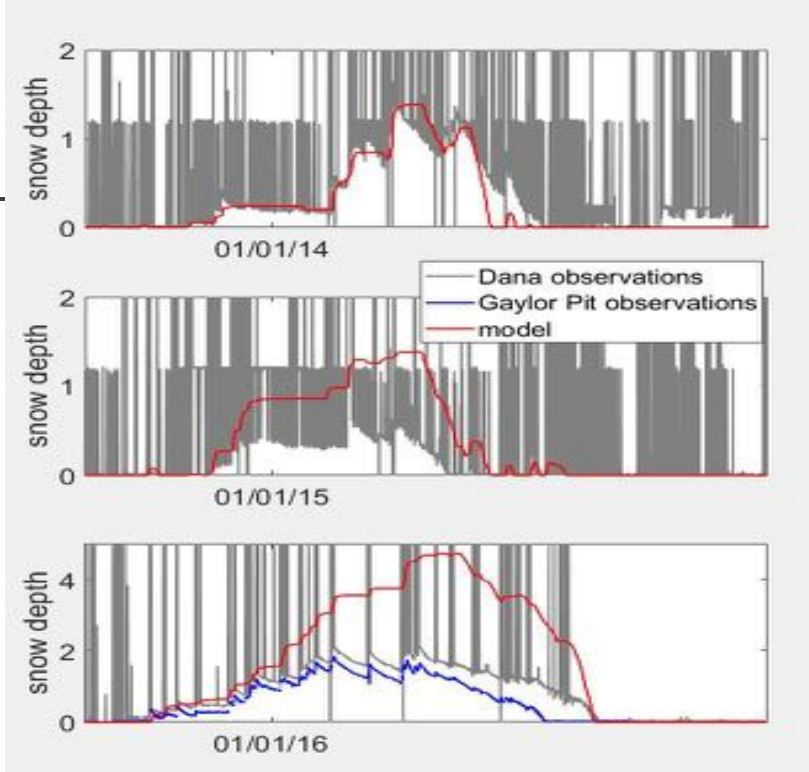
Mean SWE over entire time period for each ensemble member.



Point comparisons

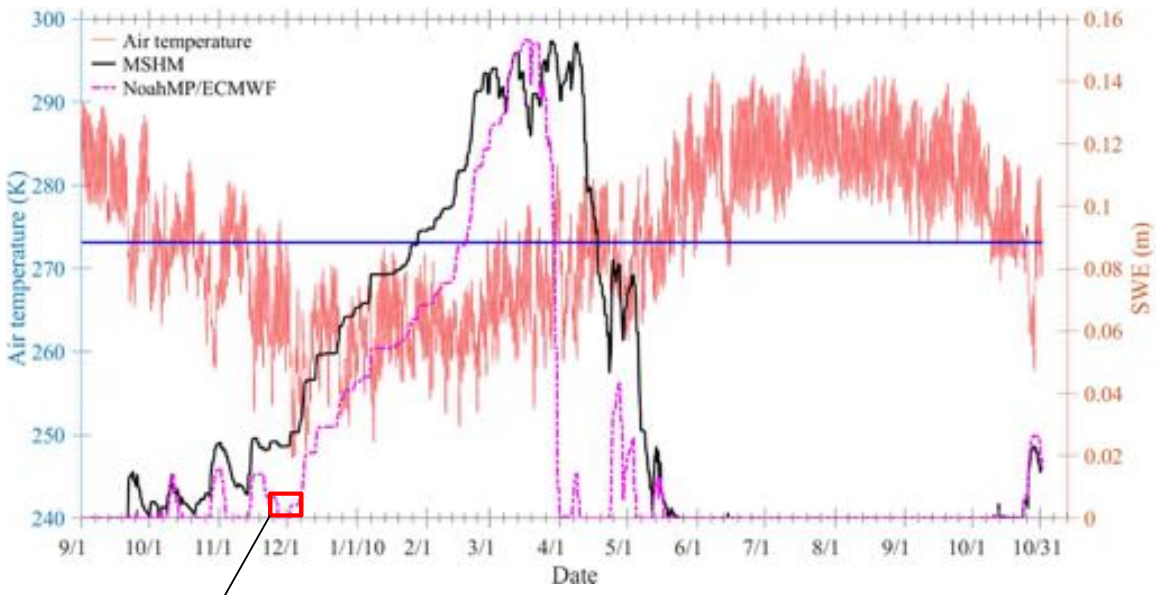


Point comparison of Noah-MP results with ECMWF forcing compared to ground observation in the Olympic Mountains in 2016 (Justin Pflug, UW).



Point comparison of JULES results compared to ground observation in the Sierra Mountains over three years.(Nicoleta Cristea, UW)

Point Comparison

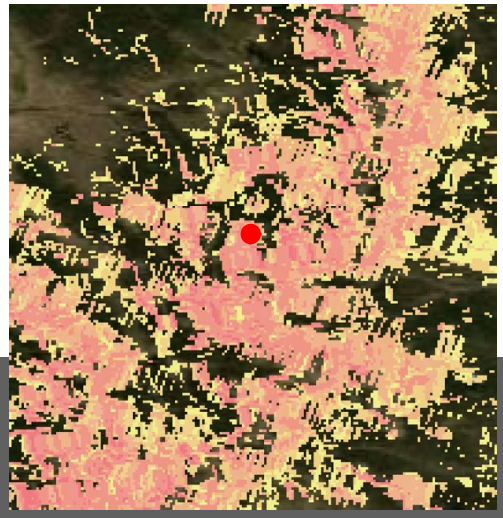


Time during which NoahMP results showed that there was no snow cover at the simulation point but MODIS snow cover data (normalized difference snow index) demonstrate there was indeed snow cover at that point during the period (Yueqian Cao, Duke University).

12/1/2009

The figures' resolution (per pixel) is 30 m, the red circles represent the ffsp03.

11/27/2009

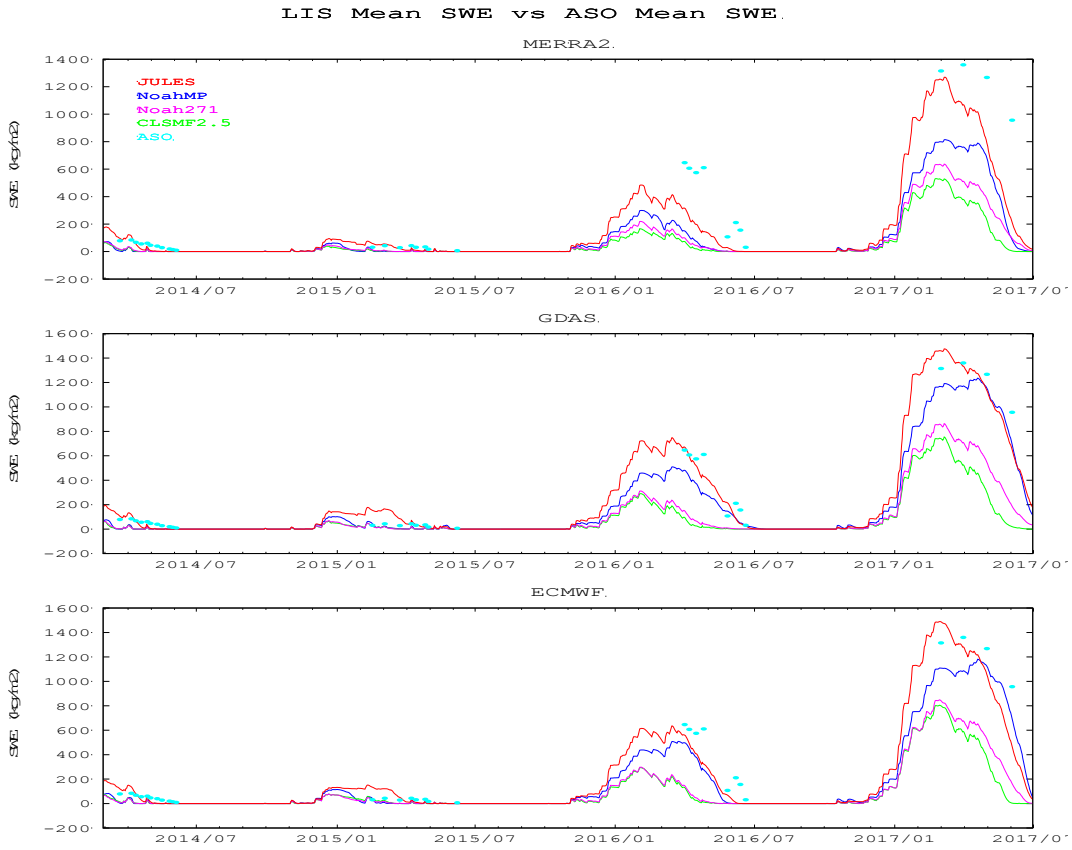


Spatial Comparison

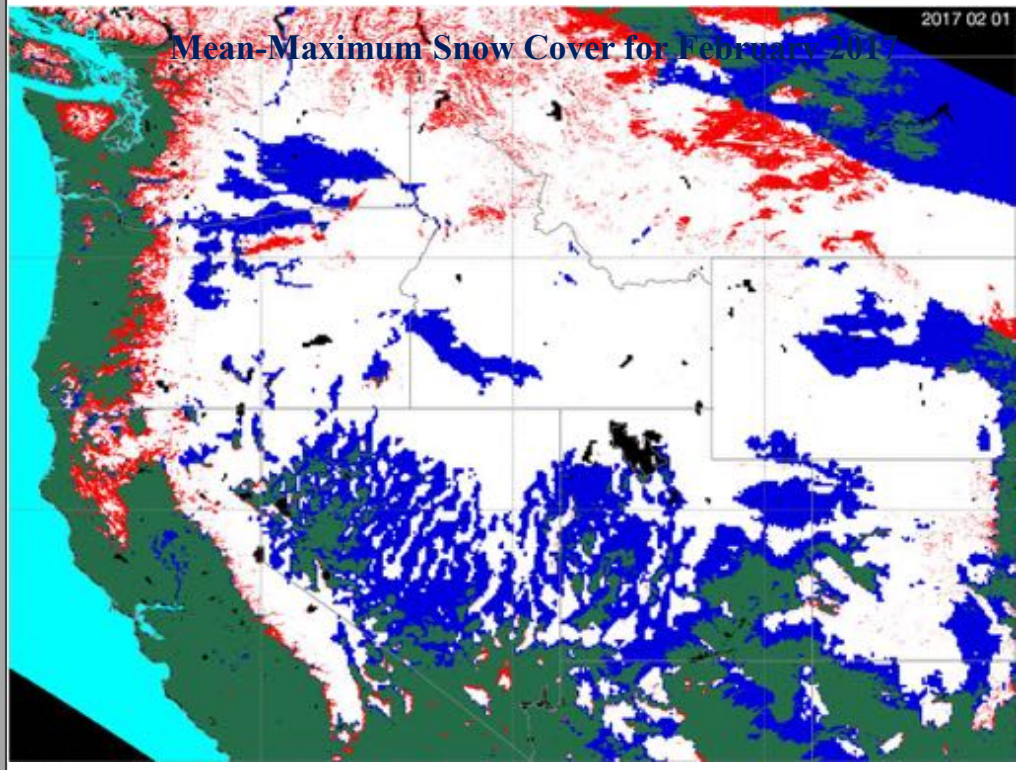
RMSE (kg/m2)

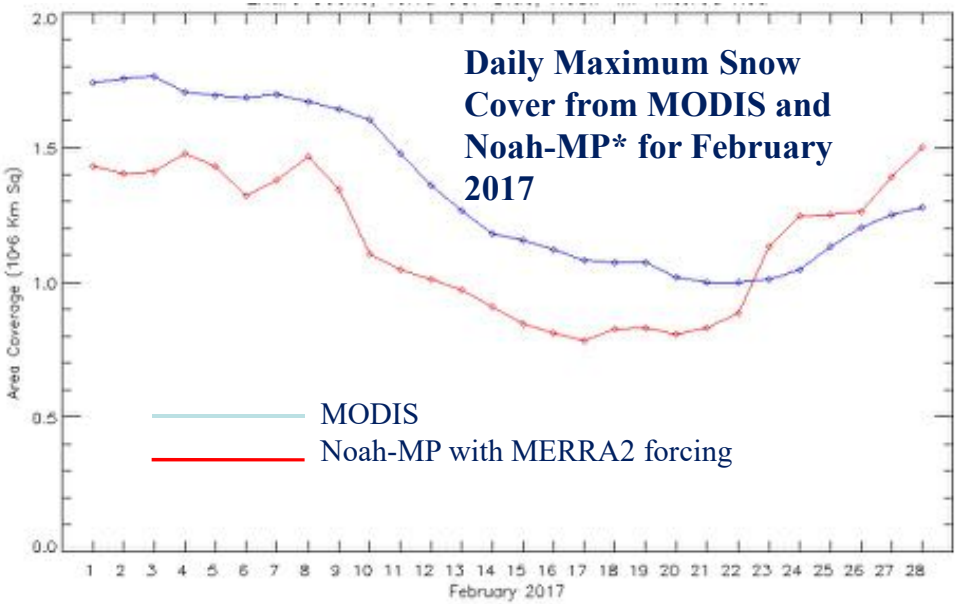
	MERRA2	GDAS	ECMWF
Noah271	193.15	166.79	163.54
NoahMP	171.64	128.31	118.19
CLSMF25	219.71	202.22	189.05
JULES	164.28	190.66	164.07

Spatial comparison of ensemble results to ASO in Tuolumne Basin (Rhae Sung Kim, NASA).



Comparison of MODIS-derived snow extent and Noah-MP* modeled snow extent for the western United States - February 2017





*with MERRA2 forcing

Snow on both

MODIS only

Noah-MP* only

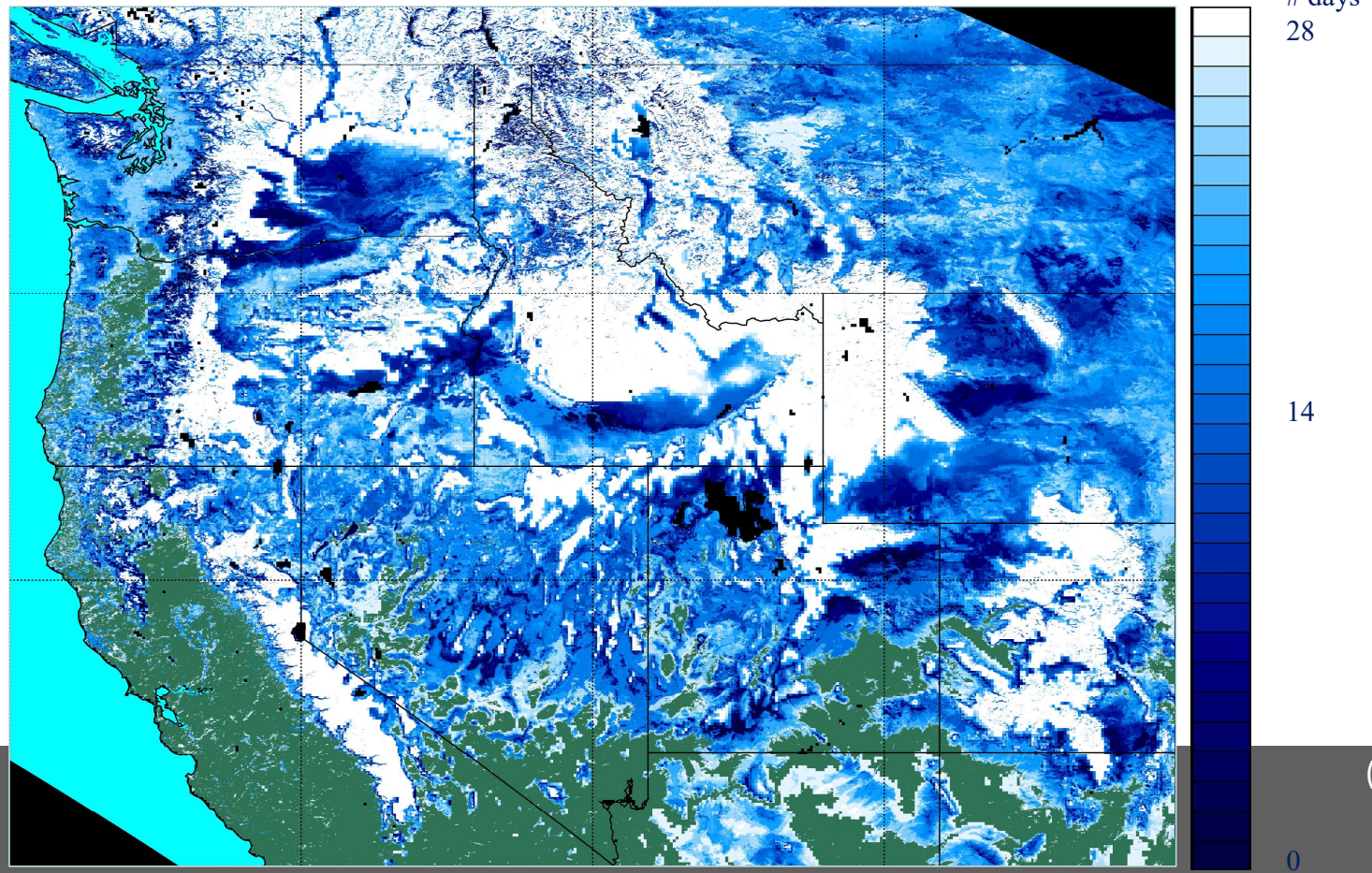
Non-snow-covered Land

No Data

AGU SnowEx TownHall
13 December, 2018

(Dorothy Hall and Nick Digirolamo, NASA)

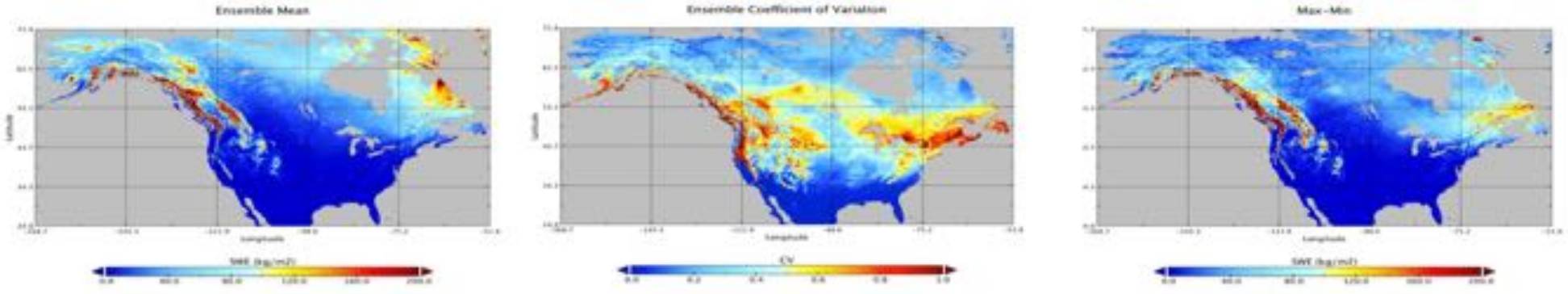
Agreement between the MODIS CGF- and the Noah-MP* model-derived snow extent for the month of February 2017

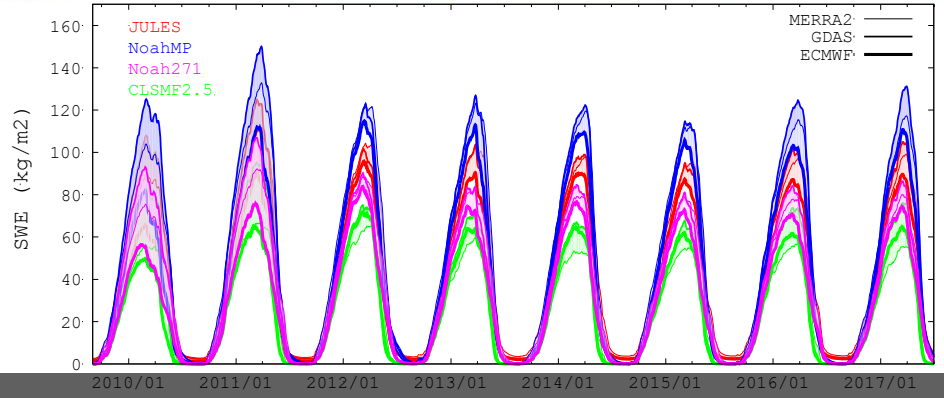


*with MERRA2 forcing

(Dorothy Hall and Nick Digirolamo, NASA)

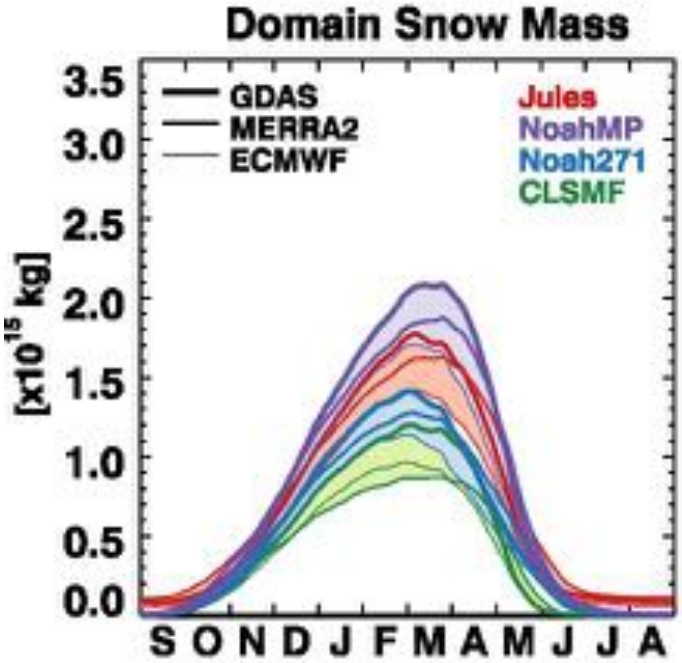
Uncertainty Analysis

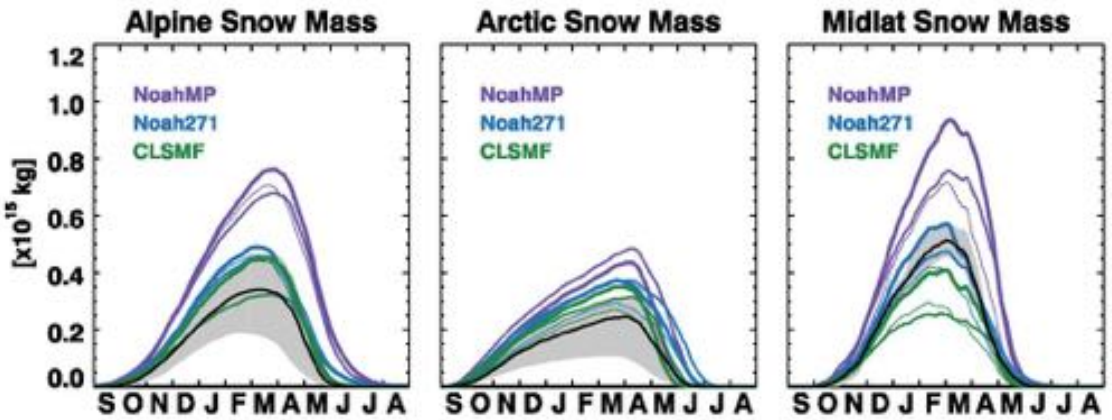




Analysis of spatial and temporal uncertainty in the ensemble results (Rhae Sung Kim, NASA)

Uncertainty Analysis





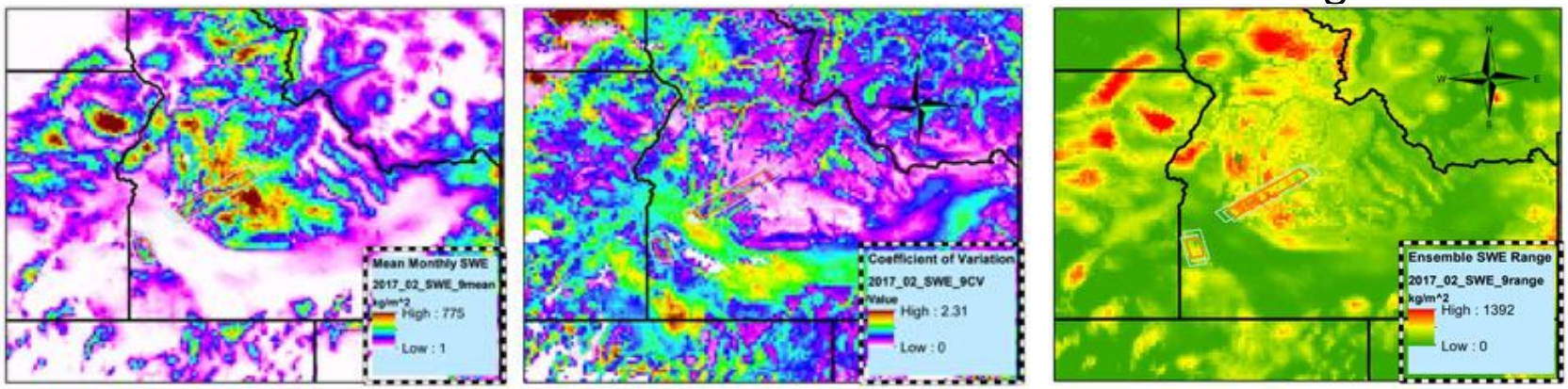
Characterize spatial and temporal variability, and identify specific regional and seasonal factors that drive uncertainty in SWE estimation (Lawrence Mudryk, EC).

SnowEx 2019

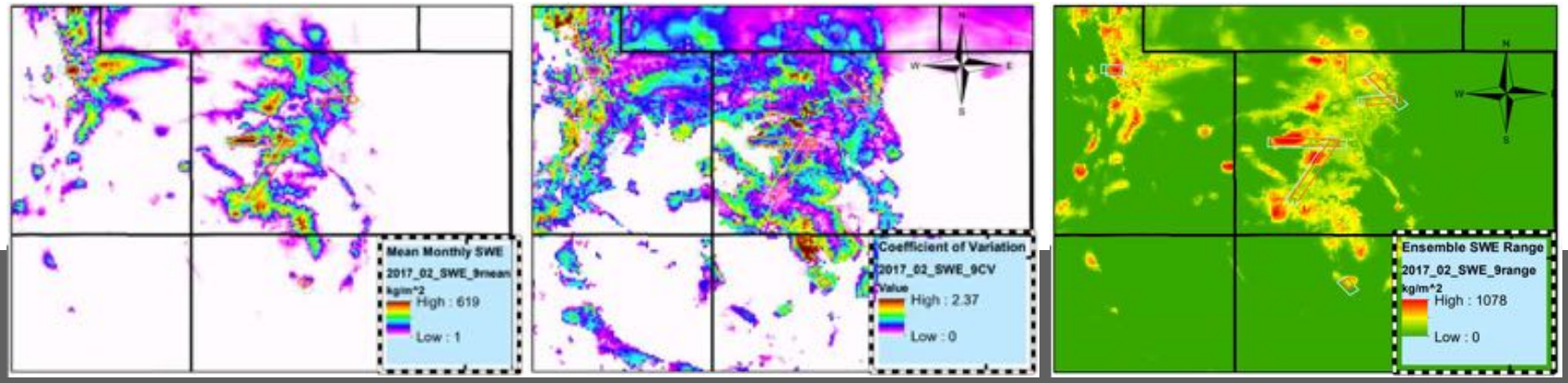
February 2017 – Example Wet Month (Jeremy Johnston, GMU)

Mean Ensemble SWE | Coefficient of Variation | Range

Idaho



Colorado



Produced by Jeremy Johnston, GMU

Next Steps

- Continue analysis of SEUP results
- Analyze Alaska region for 2020 campaign
- Begin design of Phase 2 & 3